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Andrew J. MacGregor
Amber L. Dougherty
Jonathan A. Mayo
Mitchell J. Rauh
Michael R. Galarneau

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San Diego, California 92106

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Occupational Correlates of Low Back Pain Among U.S. Marines Following Combat Deployment

LCDR Andrew J. MacGregor, MSC USN; Amber L. Dougherty, MPH; Jonathan A. Mayo, MPH; Mitchell J. Rauh, PhD, PT, MPH; Michael R. Galarneau, MS

ABSTRACT Many U.S. Marines have experienced routine combat deployments during Operation Iraqi Freedom, which present numerous occupational hazards that may result in low back pain (LBP). The objective of this retrospective cohort study was to identify new-onset LBP among Marines following initial deployment to Operation Iraqi Freedom. Active duty Marines deployed to Iraq or Kuwait between 2005 and 2008 were identified from deployment records and linked to medical databases (n = 36,680). The outcome of interest was an International Classification of Diseases, 9th Revision, Clinical Modification code indicating LBP (724.2) within 1 year postdeployment. Multivariate logistic regression examined the effect of occupation on LBP. Overall, 4.1% (n = 1,517) of Marines were diagnosed with LBP. After adjusting for covariates, the service/supply (odds ratio 1.33, 95% confidence interval, 1.12–1.59) and electrical/mechanical/craftsworker occupations (odds ratio 1.31, 95% confidence interval, 1.12–1.53) had higher odds of LBP when compared to the administrative/other referent group. Within these groups, the highest LBP prevalence was in the construction (8.6%) and law enforcement (6.2%) subgroups. Although infantry occupations purposefully engage the enemy and often face sustained physical rigors of combat, LBP was most prevalent in noninfantry occupations. Future studies should include detailed exposure histories to elucidate occupation-specific etiologies of LBP in order to guide prevention efforts.

INTRODUCTION

In early 2003, a mass deployment of Marines to Kuwait preceded the onset of Operation Iraqi Freedom (OIF). Following the initial invasion of Iraq, the mission quickly turned to stability operations, which continued for several years.[1] A variety of occupational specialties were required during this period, ranging from infantry to service, support, and logistics personnel. An array of occupational duties can place physical strain on the body.[2] Infantry occupations directly engage the enemy and often face the physical rigors of sustained combat, which may include carrying a heavy combat load (e.g., personal protective equipment). Some logistical occupations may require repetitive motions, such as driving vehicles or continuous heavy lifting of supplies. Construction personnel are often tasked with supporting infrastructure initiatives among the native community, physically assisting with reconstruction efforts to rebuild damaged schools and homes, and may be prone to workplace accidents and falls. Further, technical personnel are required to provide maintenance and repair services for both land and air military vehicles, which could require remaining in awkward positions for extended periods of time. The different experiences across these military occupational specialties may result in acute and chronic musculoskeletal disorders.

Naval Health Research Center, 140 Sylvester Road, San Diego, CA 92106-3521.

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Low back pain (LBP), a musculoskeletal condition, is a leading cause of morbidity in the military.[3,4] Acute LBP can lead to lost work time,[5] lower self-rated health,[6] and can predict disability years later.[7–9] A recent study summarized the burden of LBP across all military branches and found an annual rate of approximately 4.1%.[10] That study, however, did not address the potential mediating effects of deployment and occupation. Although other military studies have examined LBP among specific occupations, such as aviators,[11,12] combat engineers,[13] mechanics,[14] and artilleryman,[13] none evaluated LBP among the entire spectrum of military occupations. Although one large population-based study in an Army population examined back complaints across different occupations, it did not focus specifically on LBP.[15]

The diversity of work-related stressors in current wartime operations warrants a thorough review of LBP prevalence across occupations. The objective of the present study was to identify new-onset diagnoses of LBP among a cohort of Marines following initial deployment to OIF. Specifically, the aims were to (1) examine the role of occupation on new-onset LBP after adjusting for demographic- and deployment-specific covariates and (2) highlight and discuss occupational specialties with the highest prevalence of new-onset LBP.

METHODS

Study Population

In this retrospective cohort study, 362,069 active duty, enlisted Marines were identified from electronic deployment records maintained by the Defense Manpower Data Center (DMDC). Of these, only personnel with a first deployment to OIF between January 2005 and November 2008, and without a second deployment within 365 days of the end-date of their

first deployment were eligible for analysis (n = 45,898). A deployment was defined as greater than 1 month and less than 18 months. Personnel with a previous back-related diagnosis (International Classification of Diseases, 9th Revision, Clinical Modification [ICD-9-CM] 724 series) (n = 4,888), missing demographic information (n = 4,075), or who died during deployment (n = 255) were excluded. A total of 36,680 Marines met these criteria and comprised the study population. This study was conducted in compliance with all applicable federal regulations governing the protection of human subjects in research and was approved by the Institutional Review Board at Naval Health Research Center, San Diego, California.

Outcome Ascertainment

Inpatient and outpatient diagnoses were obtained from the Standard Inpatient Data Record (SIDR) and Standard Ambulatory Data Record (SADR) databases, managed by the Office of the Secretary of Defense, Health Affairs, TRICARE Management Activity. In SIDRs and SADRs, diagnoses are coded at military treatment facilities and federally reimbursed private clinics using ICD-9-CM codes.[16] New-onset diagnosis of LBP was defined as presence of an ICD-9-CM code of 724.2 (lumbago) over the course of deployment or within 1 year of end of deployment.

Military Occupation

Occupation was identified from Department of Defense (DoD) standard occupational classification codes.[2] These codes were abstracted from DMDC electronic deployment records. Broad occupation groups were identified as infantry, communications/intelligence, service/supply, electrical/mechanical/craftsworker, and administrative/other. For groups with elevated odds of LBP, occupation was further categorized into subspecialties, also identified from DoD occupational codes.

Covariates

Demographic variables were identified from electronic DMDC records. Military rank was categorized as junior (E1–E3), midlevel (E4–E5), and senior enlisted (E6–E9). Both men and women were analyzed. Deployment days were categorized as 1 to 7 months and >7 months. Age was dichotomized into 18 to 24 years and ≥25 years. Location country of deployment was identified as Iraq or Kuwait. Blast injury was identified from the Expeditionary Medical Encounter Database (EMED), formerly known as the Navy-Marine Corps Combat Trauma Registry. The EMED contains point-of-injury clinical records of injury encounters during OIF. A more detailed explanation of the EMED can be found elsewhere.[17]

Second Deployment

Rates of second deployment were calculated to examine the association between LBP and deployment status. A second deployment was defined by a DMDC record of deployment after the 365-day observation period following the first deployment.

Statistical Analysis

All analyses were conducted in SAS software, version 9.2 (SAS Institute, Cary, North Carolina). Descriptive characteristics were presented for the study population. Multivariate logistic regression was used to identify the association between occupation and LBP. The Hosmer–Lemeshow test was used to assess model fit. Occupational groups at significantly higher risk of LBP were further examined by subspecialties, and prevalence of LBP was presented. Rates of second deployment following the 1-year observation period were compared between outcome groups with χ^2 statistics.

RESULTS

Table I presents descriptive characteristics of the 36,680 Marines identified for analysis. Approximately 81.8% of personnel were aged 18 to 24 years and most (63.1%) were of ranks E1–E3. The study population was predominantly male (95.1%). Approximately two-thirds (66.2%) of the population were deployed to Iraq, and 70.1% had been deployed for 7 months or less. Few Marines (1.4%) incurred a blast injury during deployment. The electrical/mechanical/craftsworker and infantry occupations together comprised approximately 59.5% of the population. Administrative/other and service/supply were next highest at 17.4% and 15.9%, respectively.

Overall, 4.1% (n = 1,517) received a diagnosis for LBP within 1 year postdeployment. As shown in Figure 1, the highest prevalence of LBP was among the service/supply occupations. Results of multivariate logistic regression are shown

TABLE I. Sample Characteristics, U.S. Marines Deployed to OIF, January 2005–November 2008 (n = 36,680)

Characteristic	No. (%)
Age, Years	
18–24	30,002 (81.8)
≥25	6,678 (18.2)
Rank	
E1–E3	23,147 (63.1)
E4–E5	10,528 (28.7)
E6–E9	3,005 (8.2)
Sex	
Male	34,879 (95.1)
Female	1,801 (4.9)
Location Country	
Kuwait	12,390 (33.8)
Iraq	24,290 (66.2)
Time Deployed	
1–7 Months	25,704 (70.1)
>7 Months	10,976 (29.9)
Blast Injury	
No	36,179 (98.6)
Yes	501 (1.4)
Occupation	
Administrative/Other	6,370 (17.4)
Communications/Intelligence	2,618 (7.1)
Infantry	10,758 (29.3)
Service/Supply	5,847 (15.9)
Electrical/Mechanical/Craftsworker	11,087 (30.2)

in Table II. After adjusting for covariates, service/supply (odds ratio [OR] 1.33, 95% confidence interval [CI], 1.12–1.59) and electrical/mechanical/craftsworker (OR 1.31, 95% CI, 1.12–1.53) occupations had significantly higher odds of new-onset LBP relative to administrative/other occupations. In addition, women had higher odds of LBP compared with men (OR 1.94, 95% CI, 1.61–2.34). The strongest predictor of LBP was blast injury (OR 2.29, 95% CI, 1.64–3.19). Those deployed to Kuwait compared with Iraq had slightly higher odds of LBP (OR 1.11, 95% CI, 1.00–1.24). Neither infantry-related occupation nor longer deployment time was associated with LBP. A good model fit was indicated by the Hosmer–Lemeshow test for the multivariate model (p value = 0.85).

Subgroups of the service/supply and electrical/mechanical/craftsworker occupation groups are shown in Table III. Excluding the generic "other" groups, the highest prevalence of new-onset LBP was found in construction (56 of 650; 8.6%), law enforcement (49 of 789; 6.2%), materiel receipt/storage/issue (85 of 1,424; 6.0%), and automotive repair (166 of 2,875; 5.8%). The lowest LBP prevalence was found in the subgroups indicating mechanical-precision equipment (3 of 112; 2.7%), craftswork-metalworking (6 of 179, 3.4%), craftswork-utilities (24 of 689; 3.5%), and mechanical-aircraft and aircraft-related (76 of 1,954; 3.9%).

The overall rate of second deployment in the study sample was 31.4%, with a lower rate among those with a diagnosis of LBP (317 of 1,517; 20.9%) compared with those without LBP (11,186 of 35,163; 31.8%). As shown in Figure 2, this finding was consistent among all occupational groups (p values < 0.001). Among those with a second deployment, length of deployment did not differ between those with LBP and those without (198.1 vs. 202.9 days, p value = 0.28).

TABLE II. Multivariate Logistic Regression Model, LBP Among U.S. Marines Deployed to OIF, January 2005–November 2008 (n = 36,680)

Variable	OR	95% CI	p Value
Age, Years			0.18
18–24	Ref		
≥25	1.13	0.94–1.36	
Rank			<0.01
E1–E3	Ref		
E4–E5	0.73	0.64–0.83	<0.01
E6–E9	0.98	0.76–1.26	0.23
Sex			
Male	Ref		
Female	1.94	1.61–2.34	<0.01
Location Country			
Iraq	Ref		
Kuwait	1.11	1.00–1.24	0.05
Time Deployed			
1–7 Months	Ref		
>7 Months	1.06	0.95–1.19	0.31
Blast Injury			
No	Ref		
Yes	2.29	1.64–3.19	<0.01
Occupation			<0.01
Administrative/Other	Ref		
Communications/Intelligence	0.82	0.64–1.06	0.13
Infantry	0.86	0.73–1.02	0.09
Service/Supply	1.33	1.12–1.59	<0.01
Electrical/Mechanical/Craftsworker	1.31	1.12–1.53	<0.01

DISCUSSION

A variety of military occupations have been utilized during OIF. The present study found that new-onset LBP was most prevalent among noninfantry occupations, with the highest prevalence among those involved in construction. The overall prevalence of LBP found in this study was 4.1%, which is consistent with a recent article that examined LBP across all services.[10] The primary difference with the present analysis was the attempt to identify deployment-related LBP by restricting the observation period to within 1 year of the deployment end date. We also found significantly lower rates of second deployment among those with LBP, which indicates LBP may adversely affect military readiness. Our results suggest it may be advantageous to develop occupation-specific preventive health programs for LBP that can be initiated in the predeployment period. This process could begin by examining what unique predeployment experiences or training infantry-related occupational groups obtain that predisposes them to a lower prevalence of postdeployment LBP.

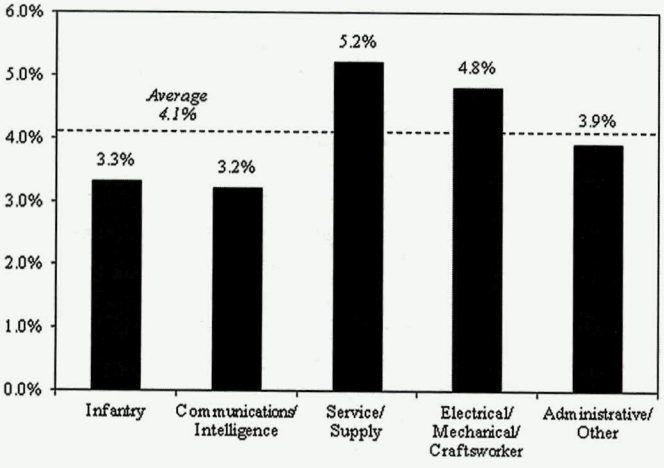

FIGURE 1. Prevalence of low back pain by occupational group.

The higher occurrence of LBP among occupations involving construction, materiel receipt, and automotive repair is consistent with the literature in analogous, civilian occupations.[18] Law enforcement was also identified as an occupation with a greater burden of LBP. This suggests that even in a mostly young adult population returning from an initial combat deployment, certain military occupations may be at increased risk for acute LBP, which may progress into more chronic conditions that could affect their military service. The etiology of occupation-specific LBP requires further study. Although strenuous duty likely plays a large part in the occurrence of new-onset LBP, the effect of combat load carriage (i.e., military equipment and supplies carried by the

TABLE III. Prevalence of LBP for Occupation Subgroups Service/Supply and Electrical/Mechanical/Craftsworker

Occupation Group	Total	LBP	
		No.	(%)
Service/Supply			
Law Enforcement	789	49	6.2
Food Service	519	28	5.4
Motor Transport	2,645	121	4.6
Materiel Receipt, Storage, Issue	1,424	85	6.0
Other	470	18	3.8
Electrical Equipment Repairers			
Radio/Radar	1,809	75	4.1
Missile Guidance, Control, and Checkout	521	26	5.0
Other	125	9	7.2
Mechanical Equipment Repairers			
Aircraft and Aircraft Related	1,954	76	3.9
Armament and Munitions	1,494	61	4.1
Automotive	2,875	166	5.8
Precision Equipment	112	3	2.7
Wire Communications	632	26	4.1
Craftsworkers			
Construction	650	56	8.6
Metal Working	179	6	3.4
Utilities	689	24	3.5
Other	47	3	6.4

individual, including body armor) needs to be investigated.[19] In particular, construction and law enforcement personnel work in the native community and off base where combat gear measures may be more strictly enforced. One recent survey found that U.S. soldiers deployed to Iraq often attributed their back and other musculoskeletal pain to body armor[20] and a civilian study among police officers found that wearing body armor was a strong predictor of new-onset LBP.[21] The true etiology of LBP is likely influenced by multiple factors; however, as a series of recent review articles suggests that no single occupational exposure is a primary predictor of LBP.[22–26] Detailed collection of exposure information is essential for future military studies on LBP in order to identify different contributing factors by occupation and to refine occupation-specific LBP prevention efforts.

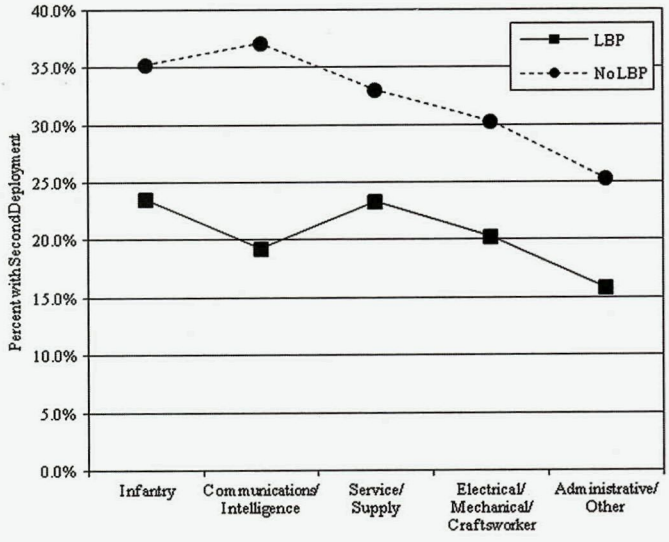

FIGURE 2. Percent of Marines with a second deployment by occupational group and low back pain diagnosis.

The finding that women have higher odds of LBP may be the result of several factors. First, civilian research has identified a similar association and has presented multiple etiological hypotheses, including differential pain responses and psychosocial factors.[10,27] Second, Strowbridge[28,29] found that female British soldiers were more than twice as likely to report LBP resulting from work or occupation compared with their male counterparts, which may suggest gender differences in the physical response to combat load carriage. Knapik et al[19] also discussed this possibility, noting an increased number of physical health complaints among women compared with men after carrying a range of different combat loads on a road march. Future research examining the ideal weight of the combat load should include both infantry personnel and support occupations to assess the possible mediating effect of gender. Alternatively, we cannot rule out the effect of bias since women are generally more likely to present for medical care.[30] Another finding of interest was the strong association between blast injury and LBP, possibly indicating tertiary effects of the blast.[31] Somewhat surprisingly, infantry personnel had a low prevalence of LBP, which may be a result of a higher level of physical fitness, which in at least one study was protective against LBP.[32]

The primary strength of this study was the ability to identify personnel following initial deployment to OIF using electronic records. This allowed for a large sample size, as well as the identification of multiple covariates from electronic deployment records and linkage to medical databases in order to exclude persons with previous back-related disorders. In addition, the capability to merge these records with the EMED allowed for the identification of blast injury, which likely adjusted for some differences in combat exposure across occupations.

Some limitations of the study should be noted. The use of ICD-9-CM codes for the identification of LBP, which are contingent on the service member presenting for care, may have resulted in an underestimate of LBP prevalence. In addition, the ICD-9-CM codes were abstracted from existing electronic records and not further validated, and thus the effect of incorrect coding or intercoder reliability could not be assessed. Although DoD occupational codes were clearly defined for all personnel, there was no information on what specific duties were performed during deployment. As such, exposures were inferred from these generalized occupational codes. Further, data for possible direct causes of LBP were not consistently available for adequate determination of their effects as risk factors for LBP. Finally, though statistically significant, the magnitude of the ORs for the occupation subgroups and LBP was low; thus, clinical significance of these findings needs to be explored in future studies.

In summary, military occupation predicts incidence of new-onset LBP following combat deployment. Future research

should collect more specific exposure information (e.g., body mass, poor core strength, hours in activities suggested to increase strain on low back) on personnel before, during, and after deployment, preferably through survey design to identify more focused areas of intervention and potential mitigation, which may result in preventive health programs tailored to specific occupations. In addition, the possible mediating effects of gender and combat load carriage need to be investigated. As protracted combat military operations continue, conditions such as LBP that affect a service member's short- and long-term health need to be further researched in order to maximize overall force readiness.

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6. AUTHORS
Andrew J. MacGregor, Amber L. Dougherty, Jonathan A. Mayo, Mitchell J. Rauh, Michael R. Galarneau

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Commanding Officer
Naval Health Research Center
140 Sylvester Rd
San Diego, CA 92106-3521

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Commanding Officer
Naval Medical Research Center
503 Robert Grant Ave
Silver Spring, MD 20910-7500

Chief, Bureau of Medicine and Surgery
(MED 00), Navy Dept
2300 E Street NW
Washington, DC 20372-5300

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14. ABSTRACT

Since the initiation of Operation Iraqi Freedom in 2003, many U.S. service members have experienced routine deployments to combat environments, which present numerous occupational hazards that may result in musculoskeletal conditions such as low back pain (LBP). Active-duty U.S. Marines with an initial deployment to Iraq or Kuwait between 2005 and 2008 were identified from electronic deployment records and linked to medical databases (*n* = 36,680). The outcome of interest was an ICD-9-CM code indicating LBP (724.2) within 1 year postdeployment. Multivariate logistic regression examined the effect of occupation on LBP. Overall, 4.1% (*n* = 1,517) of Marines were diagnosed with LBP within 1 year postdeployment. After adjusting for covariates, the occupational groups: service/supply (odds ratio [OR] 1.33, 95% confidence interval [CI], 1.12–1.59) and electrical/mechanical/craftsworker (OR 1.31, 95% CI, 1.12–1.53) had higher odds of LBP when compared with the referent group administrative/other. Within these groups, the highest LBP prevalence was in the construction (8.6%), law enforcement (6.2%), materiel receipt, storage, issue (6.0%), and automotive repair subgroups (5.8%). In summary, while infantry occupations purposefully engage the enemy and often face sustained physical rigors of combat-related activity, LBP was most prevalent in non-infantry occupations. Future studies should include detailed exposure histories to elucidate occupation-specific etiologies of LBP in order to guide prevention efforts.

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